

NUMBER GS-12-1687	TYPE PRODUCT SPECIFICATION	Amphenol FCI	
TITLE PwrMAX[®] IO Cable To Board Connector System		PAGE 1 of 10	REVISION A
		AUTHORIZED BY Zhi-Jun He	DATE Nov,21, 2022
		CLASSIFICATION UNRESTRICTED	

1.0 Objective

This specification defines the performance, test, quality and reliability requirements of the PwrMAX[®] IO cable to board connector system.

2.0 Scope

This specification is applicable to the termination characteristics of the PwrMAX[®] IO Connector System which provides a separable interface right angle board plugs that mate to vertical cable receptacles.

3.0 Ratings

3.1 Operating Voltage Rating: 300V_{AC and DC} for power contact, 110V_{AC and DC} for signal contact

3.2 Operating Current Rating: refer to values in the table in section 6.6.

3.3 Operating Temperature Range = -55°C ~ +95°C¹

Operating temperature is tested in accordance with EIA-364-17 Method A for 250 hours at 105°C per EIA-364-1000 Table C.1 to meet field temperature of 65°C for 10 years field life

Note 1: includes the terminal temperature rise when powered

4.0 Applicable Documents

4.1 AFCI Specifications

4.1.1 Engineering drawings: 10157515, 10159717 etc.

4.1.2 Application specification: GS-20-0690

4.2 National or International Standards

4.2.1 Flammability: UL94V-0 or similar applicable specification

4.2.2 EIA 364: Electrical Connector/Socket Test Procedures Including Environmental Classifications.

4.2.3 SAE/USCAR 21: Performance specification for Cable-to-Terminal Electrical Crimps

4.2.4 EIA-J-STD-002: Environmental Solder ability Tests for Component Leads, Termination, Lugs, Terminals and Wires

4.3 Laboratory Reports - Supporting Data

DL-2021-09-030-CR

4.4 Safety Agency Approvals

UL/CSA File #: E66906 Vol. 1 Sec. 202

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5.0 Requirements

5.1 Qualification

Connectors furnished under this specification shall be capable of meeting the qualification test requirements specified herein.

5.2 Material

The material for each component shall be as specified herein or equivalent

Power Contacts: Copper alloy

Signal Contacts: Copper alloy

Header and Receptacle Housings: High temperature thermoplastic, UL 94V-0 compliant

Retention clip: Copper alloy

5.3 Finish

The finish for applicable components shall be as specified herein or equivalent

Contact Area (power & signal):

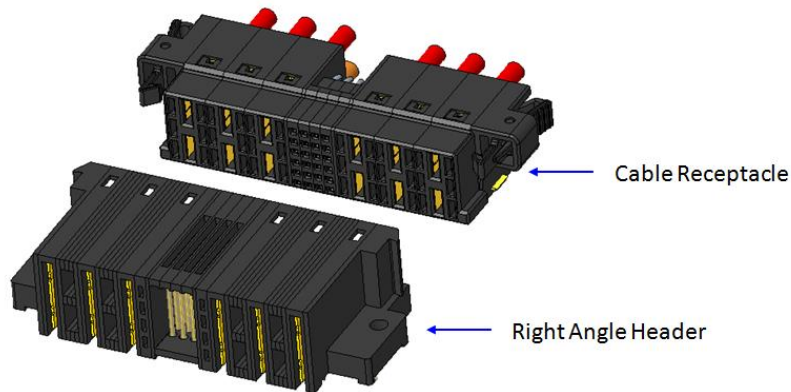
GCS® or GXT® for Power contacts, GXT® for Signal contacts

Tails (power & signal): Tin plated over Nickel

Crimp Area (Cable I/O): Tin plated over Nickel

5.4 Design and Construction

Connectors shall be of the design, construction, and physical dimensions specified on the applicable product drawing. There shall be no cracks, burrs, or other physical defects that may impair performance.



Right Angle Header mates with Cable receptacle

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6.0 Electrical Characteristics

6.1 Contact Resistance, Low Level (Signal)

The low level contact resistance shall not exceed 30 milliohms initially. The low level contact resistance shall also not exceed 10 milliohms increase in resistance (from the initial measurement) after environmental expose. Measurements shall be in accordance with EIA 364-23.

The following details shall apply:

- a. Test Voltage - 20 milli-volts DC max open circuit.
- b. Test Current - Not to exceed 100 milli-amperes.

6.2 Contact Resistance, Specified Current (Power contact)

The contact resistance at a specified current shall not exceed 1.0 mΩ initially or after mating cycles and environmental exposure. Measurements shall be in accordance with EIA 364-06.

The following details shall apply:

- a. Test Current – Shown in the table in section 6.6

6.3 Contact Resistance, Low Level (Crimped power cable contact)

The low level contact resistance for Crimped power cable contact shall not exceed 1 milliohm initially or after environmental exposure. Measurements shall be in accordance with EIA 364-23.

The following details shall apply:

- a. Test Voltage - 20 milli-volts DC max open circuit.
- b. Test Current - Not to exceed 100 milli-amperes

6.4 Insulation Resistance

The insulation resistance of mated connectors shall not be less than 1000 MΩ for the Power contact, and 500 MΩ for Signal initially and after environmental exposure.

Measurements shall be in accordance with EIA 364-21

The following details shall apply:

- a. Test Voltage - 500 volts DC.
- b. Electrification Time - 2 minutes, unless otherwise specified.
- c. Points of Measurement - Between adjacent contacts.

6.5 Dielectric Withstanding Voltage

There shall be no evidence of arc-over, insulation breakdown, or excessive leakage current > 1 mA when mated connectors.

Measurements shall be in accordance with EIA 364-20

The following details shall apply:

- a. Test Voltage - 2500 volts DC (power), 1000 volts DC (signal).

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- b. Test Duration - 60 seconds.
- c. Test Condition - 1 (760 Torr - sea level).
- d. Points of Measurement - Between adjacent contacts.

6.6 Current Rating

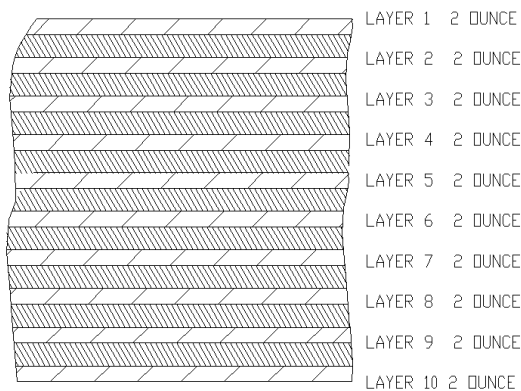
The temperature rise above ambient shall not exceed 30°C at any point in the system when all contacts are powered at specified current as below.

The following details shall apply:

- a. Ambient Conditions – still air at 25°C;
- b. Test configuration refer to the table.
- c. Reference – EIA 364-70

Wire size	Power contact (12 contacts)	Signal contact (24 contacts)
6AWG	50A/contact (2contacts/column ; 100A/column)	/
8AWG	40A/contact (2contacts/column ; 80A/column)	/
22AWG	/	1A

Figure 1 Test PC Board with 10 layers copper plane



Note: Connectors are applied to test boards with 10 layers x 2 ounces copper for power contact and 2 layers x 2 ounces copper for signal contact.

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7.0 Mechanical Characteristics

7.1 Mating/Unmating Force

The following details shall apply:

- Cross Head Speed - 25.4mm per minute.
- Lubrication: Yes
- Utilize free floating fixtures.
- Reference – EIA 364-13.

Contact Type	Mating Force (Maximum)	Un-mating Force (Minimum)
One pair of Power Contact	7N	2.2N
One pair of Signal Contact	1N	0.2N

7.2 Contact retention

Test condition: Per EIA 364-29, method C, a maximum rate of 25.4mm per minute

Requirement:

Signal contact: individual signal contact shall withstand an axial retention load of 10 N minimum.

Power Contact: individual power contact shall withstand an axial retention load of 15 N minimum.

7.3 Crimp Tensile Strength:

The force required to pull the properly crimped wire from the terminal shall not be less than the value specified in Table. If terminals are equipped with an insulation barrel, they should not be crimped to have an effect on this test. Reference – SAE/USCAR21 or UL 486A

Cable Size (AWG)	6*	8	22
Crimping Pull Force (N) min.	445	350	50

Notes:

- The specification is applicable only for board connector with cable configuration
- The specification for 6 AWG refer to UL 486A

7.4 Crimp Acceptance Criteria:

General Appearance as defined by SAE/USCAR21 section 4.2.5 and TA-681, TA-317, TA-211.

7.5 Cross Section Acceptance:

Cross section acceptance as defined by SAE/USCAR21 section 4.3.4 and 4.3.5.

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7.6 Bending Radius:

The bending radius of cable shall be 8 times of its outer diameter without any cracking to the outer cable jacket or breaking of strands of copper wires.

8.0 Environmental Conditions

After exposure to the following environmental conditions in accordance with the specified test procedure and/or details, the product shall show no physical damage and shall meet the electrical and mechanical requirements per paragraphs 6.0 and 7.0 as specified in the Table 1 test sequences. Unless specified otherwise, assemblies shall be mated during exposure.

8.1 Thermal Shock – EIA 364-32.

- a. Number of Cycles - 5
- b. Temperature Range - Between -65°C and +125°C
- c. Time at Each Temperature - 30 minutes
- d. Transfer Time - 5 minutes, maximum

8.2 Cyclic Temperature & Humidity – EIA 364-31 method IV (cyclic temperature).

- a. Relative Humidity - 80% to 98%
- b. Temperature - 25°C~65°C
- c. Duration – 10 cycles, 24h/cycle, 240 hours total
- d. Omit step 7a (cold shock)

8.3 High Temperature Life – EIA 364-17.

- a. Test Temperature - 105± 2°C
- b. Test Duration - 250 hours

8.4 Mixed Flowing Gas corrosion (MFG) – EIA 364-65

- a. Class - IIA
- b. Duration - 20 days
- c. Un-mated condition for 10 days and followed by exposure of mated connectors for the remaining 10 days

8.5 Vibration (Random) – EIA 364-28

- a. Test Condition - method VII, letter E
- b. Vibration Amplitude - 4.90 rms G, 20~500HZ
- c. Duration – 15 minutes along each of three orthogonal axes
- d. Mounting - Rigidly mount assemblies
- e. No discontinuities greater than 1 microsecond

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8.6 Mechanical Shock – EIA 364-27

- a. Condition - Test condition A (50G, 11 millisecond, half-sine pulse type)
- b. Shocks - 3 shocks in both directions along each of three orthogonal axes (18 shocks total)
- c. Mounting - Rigidly mount assemblies
- d. No discontinuities greater than 1 microsecond.

8.7 Durability - EIA 364-09

- a. Number Cycles - 200 cycles
- b. Cycling Rate - 127 mm/minute
- c. Latches disabled
- d. Use free floating fixtures

8.8 Solderability – EIA-J-STD-002,

- a. Test Condition A1
- b. Steam or dry aging - 4 hours
- c. Minimum solder coverage: 95%

8.9 Resistance to Solder Heat – EIA 364-56

- a. Condition E
- b. There shall be no evidence of physical or mechanical damage

8.10 Dust - EIA 364-91

- a. Dust Composition #1 (benign)
- b. Duration: 1.0 hour
- c. Unmated connector to be placed in the chamber

8.11 Disturb: (ref. GR-1217-CORE)

Back the fully seated header from the receptacle approximately 0.10 mm (0.004 in) and reseal fully.

8.12 Durability (preconditioning) - EIA 364-09

- a. Number Cycles - 25 cycles
- b. Cycling Rate - 127 mm/minute
- c. Latches disabled
- d. Use free floating fixtures

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9.0 QUALITY ASSURANCE PROVISIONS

9.1 Equipment Calibration

All test equipment and inspection facilities used in the performance of any test shall be maintained in a calibration system in accordance with ANSI Z-540 and ISO 9000.

9.2 Inspection Conditions

Unless otherwise specified herein, all inspections shall be performed under the following ambient conditions:

- a. Temperature: 25 +/- 5 deg C
- b. Relative Humidity: 30% to 60%
- c. Barometric Pressure: Local ambient

9.3 Sample Quantity and Description

The sample size and description is listed for each test in the appropriate section of this document.

9.4 Acceptance

9.4.1 Electrical and mechanical requirements placed on test samples as indicated in paragraphs 6.0 and 7.0 shall be established from test data using appropriate statistical techniques or shall otherwise be customer specified, and all samples tested in accordance with this product specification shall meet the stated requirements.

9.4.2 Failures attributed to equipment, test setup, or operator error shall not disqualify the product. If product failure occurs, corrective action shall be taken and samples resubmitted for qualification.

9.5 Qualification Testing

Qualification testing shall be performed on sample units produced with equipment and procedures normally used in production. The test sequences shall be as shown in the qualification test table 1. Data shall be provided with the samples noting production history: production lot codes for components and assemblies, components and assemblies produced to print revision, verification of plating composition and thickness, etc.

9.6 Re-Qualification Testing

If any of the following conditions occur, the responsible product engineer shall initiate requalification testing consisting of all applicable parts of the qualification test matrix.

- a. A significant design change is made to the existing product which impacts the product form, fit or function. Examples of significant changes shall include, but not be limited to, changes in the plating material composition or thickness, contact force, contact surface geometry, insulator design, contact base material, or contact lubrication requirements.
- b. A significant change is made to the manufacturing process which impacts the product form, fit or function.
- c. A significant event occurs during production or end use requiring corrective action to be taken relative to the product design or manufacturing process.

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9.7 Qualification Test Table

TEST GROUP ID:		1A	1B	2	3	4	5	6	7	8	9
TEST DESCRIPTION	SECTION	MFG Mated	MFG Un-Mated	Temp Life	Thermal Shock & Humidity Dielectric	Thermal shock / Humidity	Vibration / Mech. Shock	Initial Current Rating	ENV /Crimp	MECH / Crimp (completed)	Solder ability/ Resistance to Solder Heat
VISUAL EXAMINATION	5.5	1, 16	1,20	1,6	1,10	1,15	1,14	1,4	1,9	1,5	1,4
MATE HEADER & RECEPTACLE		2,	2,8,12,	2	2	2	3	2			
UNMATE HEADER & RECEPTACLE			6,10,			8	7				
ELECTRICAL:											
CONTACT RESISTANCE AT LOW LEVEL	6.1	3,5,7,9, 11,13,15	3,5,9,13, 15,17,19	3,5		3,5,7,10,12,14	4,6,9, 11,13				
CONTACT RESISTANCE AT SPECIFIED CURRENT	6.2										
Crimp Contact Resistance Low Level	6.3								2,4,6,8		
INSULATION RESISTANCE	6.4				4,7						
DIELECTRIC WITHSTANDING VOLTAGE	6.5				5,8						
CURRENT RATING	6.6							3			
MECHANICAL:											
MATING / UNMATING FORCE	7.1						2				
CONTACT RETENTION (Power & Signal)	7.2				9						
Crimp Tensile Strength	7.4									4	
Crimp Acceptance Criteria	7.5									2	
Cross Section Acceptance	7.6									3	
ENVIRONMENTAL:											
THERMAL SHOCK	8.1				3	4			3		
CYCLICAL HUMIDITY & TEMP.	8.2				6	11			5		
TEMPERATURE LIFE	8.3			4					7		
MFG - RECEPTACLE ONLY, 5 DAYS	8.4		7,11								
MFG – MATED, 5 DAYS	8.4		14,16								
MFG - MATED, 5 DAYS, 10 days, 15 days, 20 days	8.4	6,8,10, 12									
VIBRATION	8.5						10				
MECHANICAL SHOCK	8.6						12				
DURABILITY, 100 CYCLES	8.7					6,13	5				
Solder ability	8.8										2
Resistance to Solder Heat	8.9										3
DUST CONT	8.10					9	8				
DISTURB	8.11	14	18								
DURABILITY, 25 CYCLES	8.12	4	4								
SAMPLES NEEDED:											
R/A Header ASSEMBLIES		3	3	3	3	3	3	3			6
Cable RECEPTACLE ASSEMBLIES		3		3	3	3	3	3			
Cable with Power pin crimped		3		3	3	3	3	3	3	10	

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REVISION RECORD

Rev	Page	Description	EC#	Date
A	ALL	Initial release	N/A	2022-11-21